pattern and one in which it bears no necessary relation to the structure. Yet these Indians are consistent enough to make a false insert upon which the decoration is placed. In short, there are very strong reasons for concluding that the Blackfoot borrowed the decoration from their northern neighbors and that these tribes arrived at it by adjusting the decoration to the structure.

Another cut of moccasin among some tribes south of the Great Lakes requires no insert on the instep, but has a long unsightly puckered seam, extending down the middle of the foot to the toe. This is usually concealed by overlaying with a long narrow band of embroidered skin. This style extends over into the tribes of the Plains to the west where we find it upon moccasins of a pattern having no seams to hide.

Again, the Apache of New Mexico and Arizona have a moccasin with a long narrow insert reaching down the top of the foot to the toe. This gives two converging seams which are concealed by fringes and very narrow embroidered bands. Then among their northern neighbors we find moccasins without any insert whatever bearing exactly the same decoration.

Thus, in moccasin decoration we find three different examples of decorative designs developed from the structure.

We may summarize this investigation as revealing several good examples of the genesis of specific decorative designs. With one possible exception, they differ from the previous genetic studies of design in that the origin was not strictly in attempts at realistic art but merely grew out of attempts to embellish surfaces of fixed contour and to conceal unsightly lines.

The data in full will appear in the *Anthropological Papers of the American Museum of Natural History.*

THE SITUATION IN REGARD TO ROWLAND'S PRELIMINARY TABLE OF SOLAR SPECTRUM WAVE-LENGTHS

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The appearance of the *Preliminary Table of Solar Wave-lengths* marked an epoch in the history of spectroscopy and for twenty years it has been an instrument of precision in the hands of the solar and stellar investigator, to such a degree that it has become an integral part of the literature of spectroscopy. In the transition to the international system, all that is of permanent value in this work of great magnitude and im-

portance should be kept and it becomes necessary to discriminate between that which is possible to retain and that which must pass.

Several attempts have been made to determine in some general way the systematic differences between the Rowland wave-lengths and later determinations based upon the international system. Fabry and Perot[1] plotted the ratio $(\lambda R)/(\lambda \text{ international})$. To reduce the Rowland wave-lengths to the new standard, they proposed to divide the Rowland values by the corresponding ratios read from the curve. Hartmann[2] suggested the reverse procedure, namely, that wave-lengths expressed in the new system be multiplied by these ratios, reducing them to the approximate Rowland values and thus minimizing the break with the historical standard. Instead of the ratios suggested by Fabry and Perot, Albrecht in a recent paper[3] uses as ordinates the quantities, Rowland minus international, and from the mean curve derives directly the systematic difference for any line.

In many present-day discussions of solar problems, the third decimal place, when wave-lengths are expressed in angstroms, is drawn upon for the requisite data. One purpose of the present communication is to direct attention to some observations which show that a general transformation from one system to the other is a matter of the greatest difficulty if the required degree of precision is to be reached, even though the relative wave-lengths in each system were free from error, and that statistical comparison between different systems is a procedure fraught with the possibilities of introducing residuals that may be quite misleading.

For several years direct comparison between the lines of the iron arc and the solar spectrum have been in progress at this Observatory, and recently more precise determinations of the wave-lengths of iron lines dependent upon arc conditions have been made. The sun-arc comparisons show that for the lines of the same pressure group the displacements between sun and arc are, among other relations, a function of the line intensity.[4] The differences, then, between the Rowland and the international wave-lengths must be unequal even for lines in the same group and spectral region. In Table I are shown the data for two strong lines situated between weaker lines of the same group. The larger sun-arc displacements paralleling the larger Rowland-International differences for the strong lines are typical and the sun-arc data accord with the mean from a long series of determinations.

Similar systematic differences appear when lines of different groups, but in the same region, are considered, as shown in Tables II and III.[5]

TABLE I

Iron Lines of the Same Group and Spectral Region but Differing in Solar Intensity

Group	λ Rowland	Intensity	λ International	R−I	Sun−Arc
b..................	4337.216	5	.052	0.164	+0.004
b..................	4352.908	4	.740	0.168	+0.005
b..................	4383.720	15	.548	0.172	+0.012
b..................	4404.927	10	.753	0.174	+0.010
b..................	4427.482	5	.314	0.168	+0.003
b..................	4443.365	3	.198	0.167	+0.003
Mean..............................		12		0.173	+0.011
Mean..............................		4		0.167	+0.004
Intensity 12−Intensity 4				+0.006	+0.007

TABLE II

Iron Lines of Group a and d in the Same Region

Group	λ Rowland	International	R−I	Sun−Arc
d..............	5340.121	.945	0.176	−0.003
a..............	5341.213	.029	0.184	+0.009
d..............	5393.375	.178	0.197	−0.006
a..............	5397.344	.135	0.209	+0.008
Mean Group a..................................			0.196	+0.008
Mean Group d..................................			0.186	0.004
Mean Group a−Group d.........................			+0.010	+0.012

TABLE III

Iron Lines of Groups a and e in Same Region

Group	λ Rowland	International	R−I	Sun−Arc
e..............	5407.357	.136	0.221	+0.015
a..............	5405.989	.780	0.209	+0.006
e..............	5411.124	.904	0.220	+0.016
e..............	5415.416	.195	0.221	+0.026
e..............	5424.290	.064	0.226	+0.026
a..............	5429.911	.702	0.209	+0.007
a..............	5434.740	.529	0.211	+0.009
Mean Group a..................................			0.210	+0.007
Mean Group e..................................			0.222	+0.021
Mean Group e−Group a.........................			+0.012	+0.014

It is evident from the data given that no factor of transformation nor any curve can yield true differences between the Rowland and international wave-lengths for all lines even for a limited spectral region.

A comparison has recently been made between the separations of close pairs as given in the Rowland tables and as measured upon plates of higher dispersion than that used by Rowland. For pairs consisting of lines of intensities 3 and 4, whose separations are 0.0 to 0.1 A, 0.1 to 0.2 A, and 0.2 to 0.35 A, the Rowland values exceed those found at

Mount Wilson by 0.011 A, 0.007 A, and 0.004 A, respectively. These systematic differences furnish new ground for not adopting any form of operator for transforming the wave-lengths in Rowland's Preliminary Table to the international standard, and indicate some possible pitfalls incident to statistical methods of comparison.

Though the Rowland wave-lengths cannot be transformed so as to reproduce rigorously the wave-lengths expressed in the international system, it does not follow that the *Preliminary Table of Solar Wave-lengths* has outlived its usefulness. It will be some years before complete tables of solar wave-lengths, based upon the new standards, will be available, and even then the Rowland table will serve indefinitely as a reference for other things than wave-lengths. It has been assumed that the accidental errors in it are considerably greater than ± 0.01 A, but recent comparisons between certain lines in Rowland's table and their wave-lengths as measured here upon plates of a very high dispersion, 1 mm. = 0.3 angstrom, using as standards neighboring free-standing lines, show that this is an over-estimate. For 54 lines in pairs with separations between 0.25 and 0.50 angstrom, the mean variation from Rowland's values is ± 0.003 angstrom. As more than 200 lines were used as standards, it appears that, for the types of lines involved, the accidental errors in the Rowland wave-lengths are much less than 0.01 angstrom. It is probable, as Frost and Adams remark,[6] that errors of this magnitude occur but rarely and mainly then for lines whose measurement is inherently difficult, such as the very weak and the strong shaded lines. When it was first noticed that the differences between the Rowland wave-lengths in the Preliminary Table and those found by the newer arc determinations were not constant over even a short spectral region, it appears to have been assumed that the large variations were due to errors in the Rowland values, but data similar to those reported in Tables I, II, and III show that the apparent discrepancies represent real differences in the behavior of lines and tend to increase rather than destroy confidence in the accuracy of the relative wave-lengths of lines not presenting special difficulties of measurement and sufficiently separated from others to be within the power of spectrographs in common use.

[1] Ch. Fabry and A. Perot, *Astroph. J.*, **15**, 272 (1902).

[2] J. Hartmann, *Astroph. J.*, **18**, 167 (1908).

[3] Sebastian Albrecht, *Astroph. J.*, **41**, 333 (1915).

[4] Charles E. St. John, *Mt. Wilson Contr.*, No. 93, p. 35; *Astroph. J.*, **41**, 63 (1915).

[5] Charles E. St. John and L. W. Ware, *Mt. Wilson Contr.*, No. 61, pp. 31–32; *Astroph. J.*, **36**, 45–46 (1912).

[6] E. B. Frost and W. S. Adams, *Publications of Yerkes Observatory*, vol. 2, p. 155.